Supplementary information for:

Tune-in teaching: An advanced organizer mediated sustainable teaching tool

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Table S1. Validity test results of tune-in teaching tool.

Item No	Rating by Techno-Pedagogical Competence Expert (TPCE)	Rating by Pedagogical-Content Competence Expert (PCCE)	Rating by Technology-Driven Content Competence Expert (TCCE)	I-CVI= $\frac{\text{Number of Experts rating the item 3 or 4}}{\text{Total number of Experts}}$	S-CVI = ΣI-CVI/Total number of items	Remarks:
1	3	4	3	1.00	0.96 (Highly valid content)	(i) I-CVI ≥ 0.78, The item is content valid (Lynn, 1986) (ii) S-CVI ≥ 0.90, the tool is excellent (Polit and Beck, 2006)
2	3	3	3	1.00		
3	4	4	4	1.00		
4	2	3	3	0.66		
5	3	4	4	1.00		
6	4	4	4	1.00		
7	3	3	3	1.00		
8	4	4	3	1.00		
9	3	3	4	1.00		
10	4	4	4	1.00		
11	3	3	3	1.00		
12	4	4	3	1.00		
13	2	3	3	0.66		
14	3	3	3	1.00		
15	4	4	4	1.00		
16	3	3	4	1.00		
17	4	4	4	1.00		
18	3	3	3	1.00		
19	4	4	3	1.00		
20	4	4	4	1.00		
21	3	3	3	1.00		
22	4	4	2	0.66		
23	4	3	4	1.00		
24	3	3	3	1.00		
25	4	4	4	1.00		
26	3	3	4	1.00		
27	4	3	3	1.00		
28	3	3	3	1.00		
29	4	4	3	1.00		
30	3	3	4	1.00		

Table S2. Calculation based on I-CVI.

Item No	Rating by Techno-Pedagogical Competence Expert (TPCE)	Rating by Pedagogical-Content Competence Expert (PCCE)	Rating by Technology-Driven Content Competence Expert (TCCE)	I-CVI	P_0 = Mean of I-CV Values = $\frac{N_1 M_1 + N_2 M_2}{N_1 + N_2}$	P_e = Sum (proportion of each rating)^2
1	3	4	3	1.00	$\frac{27\times 1.0 + 3 \times 0.66}{27+3}$ = $\frac{27 + 1.986}{30}$ = $\frac{28.986}{30}$ = 0.966	Count of rating 2: 3 Count of rating 3: 46 Count of rating 4: 41 There are total of (30 times 3 = 90) ratings (3 experts rated 30 items). Thus, the proportions for each rating are: Proportion of 2: 3/90 = 0.033 Proportion of 3: 46/90 = 0.511 Proportion of 4: 41/90 = 0.455 Now, Pe = $(0.033)^2$ + $(0.511)^2$ +$(0.455)^2$ = 0.001089 + 0.26112 + 0.2070 = 0.4692
2	3	3	3	1.00		
3	4	4	4	1.00		
4	2	3	3	0.66		
5	3	4	4	1.00		
6	4	4	4	1.00		
7	3	3	3	1.00		
8	4	4	3	1.00		
9	3	3	4	1.00		
10	4	4	4	1.00		
11	3	3	3	1.00		
12	4	4	3	1.00		
13	2	3	3	0.66		
14	3	3	3	1.00		
15	4	4	4	1.00		
16	3	3	4	1.00		
17	4	4	4	1.00		
18	3	3	3	1.00		
19	4	4	3	1.00		
20	4	4	4	1.00		
21	3	3	3	1.00		
22	4	4	2	0.66		
23	4	3	4	1.00		
24	3	3	3	1.00		
25	4	4	4	1.00		
26	3	3	4	1.00		
27	4	3	3	1.00		
28	3	3	3	1.00		
29	4	4	3	1.00		
30	3	3	4	1.00		

Table S3. Achievement test questions (total 15 marks, each question carries 1 mark).

Item	Questions	CVR
1	Weathering means: A) Rocks are moved to new places B) Rocks are broken down where they are (in place) C) Rocks melt into magma D) Rocks grow larger	1.00
2	Which is a type of weathering? A) Mechanical (physical) B) Volcanic eruption C) Plate movement D) Tectonic uplift	1.00
3	Freeze–thaw (water freezes in cracks and breaks rock) is called: A) Chemical weathering B) Physical weathering C) Biological weathering D) Erosion	1.00
4	When minerals change to new minerals because of water, that is: A) Oxidation B) Hydrolysis (chemical weathering) C) Salt crystallization D) Abrasion	0.50
5	Plant roots widening cracks in rock is an example of: A) Physical weathering B) Chemical weathering C) Biological weathering D) Erosion	1.00
6	When iron minerals in rock react with oxygen and "rust", the process is: A) Hydrolysis B) Dissolution C) Oxidation (chemical) D) Freeze–thaw	0.50
7	Acid rain causing limestone to dissolve is called: A) Physical weathering B) Biological weathering C) Chemical weathering (dissolution) D) Exfoliation	0.50
8	Which climate speeds up chemical weathering the most? A) Cold and dry B) Warm and wet C) Cold and wet only D) Desert only	0.50
9	Lichens produce weak acids and slowly dissolve rock. This is: A) Physical weathering B) Chemical weathering C) Biological weathering (chemical by organisms) D) Erosion	0.50
10	Weathering vs erosion — which is true? A) Weathering breaks rock; erosion moves the pieces away	1.00

	B) Weathering moves rock; erosion breaks it down C) They are the same process D) Neither causes soil	
11	Exfoliation (rock layers peeling off) happens mainly because of: A) Plant roots only B) Pressure release and temperature changes (physical) C) Dissolution by acids D) Salt crystals	1.00
12	Rocks with many cracks/joints usually: A) Weather slower B) Weather faster because more surface is exposed C) Become metamorphic instantly D) Are always harder	1.00
13	Hydrolysis commonly produces: A) Clay minerals from feldspar B) Diamonds C) Basalt D) Ice	1.00
14	Salt crystals growing in rock pores causing breakage is most common in: A) Tropical rainforests B) Arid and coastal areas C) Mountain glaciers D) Deep oceans	1.00
15	Weathering helps erosion because it: A) Makes rock harder to move B) Produces loose particles that can be carried away C) Stops rivers from flowing D) Prevents soil formation	1.00

Answer key: 1-B, 2-A, 3-B, 4-B, 5-C, 6-C, 7-C, 8-B, 9-C, 10-A, 11-B, 12-B, 13-A, 14-B, 15-B.

Validity (CVR with 4 experts)

All items are provided to four experts. Among them, two are subject experts and two are pedagogy experts. They are asked to give ratings, whether the questions are essential or not for achievement test. They give a rating with three-point scale (E = Essential, U = Useful, N = Not necessary). CVR formula (Lawshe, 1975) = (Ne-N/2)/N/2. Where Ne = Number raters given as essential, N = no of experts. Here the value is 0.5 and above. So, all items are accepted (Lawshe, 1975). For example, for the first item, the four raters said that this item is essential, so, N = 4, N/2 = 2, Ne = 4 and CVR = (4/2)/2 = 1. In such a way the other calculations are done.

Reliability (pilot study on 20-student)

The question set is applied on 20 students for pilot study. By feeding the data on SPSS Cronbach's alpha was calculated and the value is 0.81 (good internal consistency for 15 items).

Table S4. Perception checklist.

Perception indicator	Perception	1 (Disagree)	2 (Neutral)	3 (Agree)
1. Conceptual clarity	Helped me understanding the geographical concept clearly.			
2. Cognitive impact	Helped me remember main theme and connect with different sub theme effectively.			
3. Learning value	Simplified complex ideas while maintaining accuracy as well as added meaning.			
4. Engagement	The lesson more interesting and encouraged new ways of thinking.			
5. Overall effectiveness	Influenced my understanding and should be used more often.			
6. Preference	I like this instruction method.			

Expert consistency reliability

The perception checklist consisting of 6 items was reviewed by a panel of five experts in the fields of Geography Education, Education, Geography, Psychology, and Language. Each expert evaluated the items of the checklist on the following criteria, i.e., clarity of the statement, alignment with the perception construct, relevance to metaphor-based instruction, appropriateness for student level.

Table S5. Expert consistency reliability.

Items	Experts agreement (out of 5)	Agreement (%)	Decision
1	5	(5/5) *100=100%	Accepted
2	5	(5/5) *100=100%	Accepted
3	4	(4/5) *100=80%	Minor revision done
4	5	(5/5) *100=100%	Accepted
5	4	(4/5) *100=80%	Minor revision done
6	5	(5/5) *100=100%	Accepted

Table S6. Standardization of perception checklist.

Validation step	Method used	Validators	Outcome
Content validity	Expert review	5 experts	According to the expert's opinion all items are accepted after refinement of 2 and 5 item in the perception checklist
Face validity	Student readability check	6 students	Language simplified for 2 items
Expert consistency reliability	Agreement rating on item consistency with perception construct	5 experts	80–100% agreement across items; items judged consistent and reliable, make minor revision of item 2 & 5
Finalization	Approved checklist	Necessary refinement of items was done according to expert's verbal opinion	Checklist standardized

References

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